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# XXIII. *The Latitude and Longitude of* York *determined from a Variety of Aſtronomical Obſervations; together with a Recommendation of the Method of determining the Longitude of Places by Obſervations of the Moon's Tranſit over the Meridian. Contained in a Letter from* Edward Pigott, *Eſq. to* Nevil Maſkelyne, *D. D. F. R. S. and Aſtronomer Royal.*

Read June 29, 1786.

S I R, Bootham, York, March 16, 1786.

THE great number and variety of obſervations I have made for determining the longitude and latitude of York will, I believe, ſettle thoſe points very accurately: I therefore wiſh to have them preſented to the Royal Society, and beg the favour of you to be at that trouble. The inſtruments I uſed were a good gridiron pendulum clock, a 2½ feet reflector, an eighteen-inch quadrant by BIRD, and a tranſit inſtrument made by SISSON.

The difference of meridians between Greenwich and York was found by the following methods.

Occultations

## Occultations of ſtars by the moon.

| 1783 | App. time. h. ′ ″ | |
|---|---|---|
| Sept. 10 | 11 34 $44\frac{1}{2}$ | York, immerſion of a ſtar of the ninth magnitude during the eclipſe of the moon; good. |
| | | Paris, at L'Obſervatoire de la Marine; ditto. |
| | 11 49 $39\frac{1}{2}$ | Ditto, by M. MESSIER, who determined its R.A. 349° 22′ 17″ and ſouth declination 5° 27′ 54″. |
| Oct. 7 | 14 26 $28\frac{1}{2}$ | York, immerſion of φ Aquarii, inſtantaneous. |
| | 14 37 $15\frac{1}{2}$ | Greenwich, ditto. |
| Dec. 30 | 8 1 24 | York, immerſion of δ Piſcium, inſtantaneous: I find I wrote down the minute wrong, it is here corrected. |
| | 8 2 $56\frac{1}{2}$ | Greenwich, immerſion of ditto. |

Mr. GOODRICKE was ſo obliging as to be at the trouble of computing theſe occultations, and ſent me the reſults as follows:

| | | ′ ″ | |
|---|---|---|---|
| By the ſtar of the ninth magnitude - - - | | 4 29 | Difference of meridians between Greenwich and York. |
| By φ Aquarii - - - - - | | 4 23 | |
| By δ Piſcium compared to the Greenwich obſervation | 4′ 30″ | 4 29 | |
| Ditto, to Mr. WOLLASTON's obſervation, - | 4 28 | | |
| On a mean - - - | | 4 27 | |

## Obſerved meridian R.A.'s of the moon's limb.

In 1783 this method of finding the difference of meridians occurred to me, and I wrote to Mr. BAYLEY, your late Aſſiſtant, for information, being entirely ignorant it had ever been noticed; but have ſince ſeen, Sir, that you mention it in your valuable Inſtructions for the Obſervations of the Tranſit of Venus, annexed to the Nautical Almanac of 1769. I have alſo juſt peruſed on the ſame ſubject Abbé TOALDO's ingenious pamphlet written in 1784, which you were ſo kind as to ſend

me. Still I find that the great exactness of this method is not suspected; I therefore shall, in the latter part of this Paper, enter into some necessary detail, being convinced that, in a very short time, it must be universally adopted, having every advantage over Jupiter's first satellite, and but little inferior in precision to occultations.

Difference of our meridians by each observation.

| | | ′ | ″ | | | ′ | ″ |
|---|---|---|---|---|---|---|---|
| 1781, | Dec. 20. | 4 | 36 | 1784, | July 2. | 4 | 23 |
| | Dec. 29. | 4 | 10 | | Nov. 20. | 4 | 23 |
| 1782, | June 17. | 4 | 25 | | Dec. 20. | 4 | 27 |
| | Nov. 30. | 4 | 20 | | Dec. 22. | 4 | 20 |
| | Dec. 18. | 4 | 25 | 1785, | Mar. 19. | 4 | 25 |
| 1783, | Nov. 3. | 4 | 32 | | Aug. 16. | 4 | 22 |
| | Dec. 6. | 4 | 39 : | | Aug. 18. | 4 | 36 |
| | Dec. 30. | 4 | 16 | | Sept. 12. | 4 | 35 |
| 1784, | May 1. | 4 | 8 : | | Sept. 17. | 4 | 25 |
| | May 25. | 4 | 11 | | Nov. 12. | 4 | 34 |
| | | | | | Nov. 14. | 4 | 18 |

4′ 24″¼ on a mean.

Observations of Jupiter's first Satellite.

| Dates, &c. | App. time. h. ′ ″ | |
|---|---|---|
| 1782, June 3. | 12 36 48 | York, it immerged near Jupiter. |
| | 12 51 9 | Paris, M. MECHAIN. |
| Immersions. | 12 51 7 | Paris, M. CASSINI. |
| | 13 57 40 | Buda, Father WEISS. |

## Obſervations of Jupiter's firſt Satellite continued.

| Dates, &c. | App. time h. ′ ″ | |
|---|---|---|
| 1782, July 21 | 9 35 10 | York. |
| | 9 39 21 | Greenwich, Dr. MASKELYNE. |
| Emerſions. | 9 48 54 | Paris, M. MECHAIN; high wind. |
| | 9 48 46 | Paris, M. CASSINI. |
| | 10 55 15 | Buda, Father WEISS; moon very near Jupiter. |
| 1783, July 3 | 12 9 50 | York; it immerged near Jupiter. |
| Immerſions. | 12 14 20 | Greenwich. |
| | 12 24 8 | Paris, M. MECHAIN. |
| Sept. 17 | 9 48 15 | York. |
| | 9 47 44 | York, Mr. GOODRICKE; very good. |
| Emerſions. | 9 46 39 | Oxford, Mr. HORNSBY. |
| | 10 1 0 | Paris, M. MECHAIN; very good. |
| 1784, Aug. 4 | 10 10 55 | York; tolerably good. |
| Immerſions. | 10 10 57 | York, Mr. GOODRICKE; middling. |
| | 10 24 57 | Paris, M. MECHAIN; air a little hazy. |
| Sept. 3 | 14 39 52 | York; emerged near Jupiter. |
| Emerſions. | 14 53 51 | Paris; thinks rather too late. |
| Sept. 5 | 9 8 54 | York; good. |
| | 9 13 15 | Greenwich, Dr. MASKELYNE. |
| Emerſions. | 9 22 18 | Paris, M. MECHAIN; 6 feet reflector, magnifying 450 times. |
| | 9 22 45 | Paris; with a $3\frac{1}{2}$ tripl. object glaſs achromatic. |
| Sept. 12 | 11 6 9 | York; good. |
| | 11 6 24 | York, Mr. GOODRICKE; very good. |
| Emerſions. | 11 10 42 | Greenwich, Dr. MASKELYNE. |
| | 11 19 47 | Paris, M. MECHAIN; as on the 5th. |
| | 11 19 50 | Paris, M. MECHAIN; as on the 5th. |
| 1785, July 15 | 13 37 32 | York; good. |
| Immerſions. | 13 42 1 | By tables corrected by the obſervations of Greenwich and Marſeilles of July 31, 1785. |
| July 31 | 11 53 18 | York; good. |
| Immerſions. | 11 57 32 | Greenwich; air very clear. |
| | 12 18 53 | Marſeilles, M. BERNARD. |

Obſer-

Obſervations of Jupiter's firſt Satellite continued.

| Dates, &c. | App. time. | | | |
|---|---|---|---|---|
| | h. | ′ | ″ | |
| 1785, Aug. 30 | 14 | 2 | 59 | York; excellent; air remarkably clear. |
| Immerſions. | 14 | 7 | 3 | Greenwich; ditto. |
| | 14 | 28 | 33 | Marſeilles, M. BERNARD. |
| Sept. 15 | 12 | 25 | 2 | York; good. |
| | 12 | 25 | 4 | York, Mr. GOODRICKE; good; moon-light. |
| Immerſions. | 12 | 29 | 23 | Greenwich; air clear. |
| | 12 | 50 | 46 | Marſeilles, M. BERNARD. |
| Nov. 18 | 7 | 58 | 6 | York. |
| Emerſions. | 8 | 2 | 39 | Greenwich; air very clear. |
| | 8 | 12 | 2 | Paris, M. MECHAIN; a thin cloud. |
| Dec. 2 | 11 | 44 | 24 | York; Jupiter rather low. |
| Emerſions. | 11 | 49 | 13 | Greenwich; ditto; air clear. |

By letters from M. MECHAIN, Buda is 1 h. 6′ 33″ eaſt of Paris, and Marſeilles alſo eaſt 0 h. 12′ 7″.

I obſerved with a 2½ feet reflector, which I believe to be about 10″ of time inferior to the teleſcopes of Greenwich, Oxford, Paris, and Buda. As for Marſeilles no inſtrument is mentioned; therefore, except for that place, 10″ muſt be added to my immerſions, and the ſame ſubtracted from the emerſions; then the difference of meridians between Greenwich and York will be as follows, when each of the obſervations is compared to mine, and a mean thereof taken.

| Immersions. | | | Emersions. | | |
|---|---|---|---|---|---|
| | ′ | ″ | | ′ | ″ |
| 1782, June 3. | 4 | 54 | 1782, July 21. | 4 | 29 |
| 1783, July 3. | 4 | 36 | 1782, Sept. 17. | 4 | 8 |
| 1784, Aug. 4. | 4 | 36 | 1784, Sept. 3. | 4 | 53 |
| 1785, July 15. | 4 | 19 | Sept. 5. | 4 | 33 |
| July 31. | 4 | 8 | Sept. 12. | 4 | 37 |
| Aug. 30. | 4 | 3 | 1785, Nov. 18. | 4 | 46 |
| Sept. 15. | 4 | 16 | Dec. 12. | 4 | 59 |
| on a mean | 4 | 24½ | | 4 | 38 |

Therefore, by a mean of the immersions and emersions, York is 4′ 31″ west of Greenwich. Mr. Goodricke's emersion of Sept. 17, 1783, is used instead of mine, it being undoubtedly more exact.

To enter into any detail concerning the eclipses of Jupiter's satellites would be useless, as it is a matter so amply considered by every astronomer. I shall only say that the exactness expected even from those of the first satellite is, in my opinion, too highly rated. Among the various objections, there is one I have often experienced, and which proceeds solely from the disposition of the eye, that of seeing more distinctly at one time than at another. It may not be improper also to mention, that the observation I should have relied on as the best, that of August 30, 1785, marked excellent, and air remarkably clear both at Greenwich and York, is one of those which differ the most from the truth. This I remark without having the most distant inclination of drawing any conclusion; a single instance can be of no weight.

Part

Part of the eclipſe of the Moon, Sept. 10, 1783.

The two laſt columns ſhew the difference of meridians between Greenwich and York. The obſervations marked with an aſteriſk were made by Mr. GOODRICKE.

| Spots obſerved. | York, by Mr. GOODRICKE and me. App. time. | Paris, by M. MECHAIN. App. time. | Paris, by M. MESSIER. App. time. | Diff. of meridians by M. MECHAIN. | Diff. of merid. by M. MESSIER. |
|---|---|---|---|---|---|
| | h. ′ ″ | h. ′ ″ | h. ′ ″ | ′ ″ | ′ ″ |
| Galileus biſected – | 9 45 32 | 9 58 33 | – – | 3 38 | – – |
| Ariſtarchus covered – | 9 49 13* | 10 2 38 | – – | 4 2 | – – |
| Copernicus touches { | 9 57 3* | 10 11 18 | 10 11 9 | 4 52 | 4 48 |
| | 9 57 20 | 10 11 18 | 10 11 9 | 4 35 | 4 31 |
| Copernicus biſected { | 9 58 33* | 10 12 5 | – – | 4 9 | – – |
| | 9 58 55 | 10 12 5 | – – | 3 47 | – – |
| Copernicus covered – | 9 59 9* | 10 12 57 | 10 12 41 | 4 25 | 4 14 |
| Plato touches – | 10 5 7 | 10 18 37 | 10 18 40 | 4 7 | 4 15 |
| Plato covered – | 10 6 18 | 10 19 52 | 10 19 28 | 4 11 | 3 52 |
| Manilius touches – { | 10 11 26* | 10 25 34 | 10 25 24 | 4 45 | 4 40 |
| | 10 11 33 | 10 25 34 | 10 25 24 | 4 38 | 4 33 |
| Tycho touches – { | 10 11 57* | 10 25 34 | 10 25 24 | 4 14 | 4 9 |
| | 10 11 57 | 10 25 34 | 10 25 24 | 4 14 | 4 9 |
| Manilius covered – | 10 12 47* | 10 26 29 | 10 26 53 | 4 19 | 4 48 |
| Tycho covered – { | 10 13 8* | 10 27 19 | 10 27 8 | 4 48 | 4 42 |
| | 10 13 32 | 10 27 19 | 10 27 8 | 4 24 | 4 18 |
| Menelaus biſected – | 10 15 41 | 10 29 19 | – – | 4 15 | – – |
| Prom. Acut. Cen. covered | 10 25 26* | 10 39 5 | – – | 4 16 | – – |
| Proclus biſected – | 10 29 00 | 10 42 28 | – – | 4 5 | – – |
| Mare Criſium touches { | 10 30 18* | 10 43 56 | 10 44 00 | 4 15 | 4 24 |
| | 10 30 18 | 10 43 56 | 10 44 00 | 4 15 | 4 24 |
| Mare Criſium biſected | 10 32 43* | 10 46 34 | 10 46 10 | 4 28 | 4 9 |
| Mare Criſium covered | 10 35 38* | 10 49 11 | – – | 4 10 | – – |
| Grimaldus emerges – | 12 23 30 | – – | 12 37 5 | – – | 4 17 |
| Grimaldus biſected – | 12 23 44 | 12 36 48 | – – | 3 41 | – – |
| Grimaldus emerged { | 12 23 55* | 12 37 25 | – – | 4 7 | – – |
| | 12 23 59: | 12 37 25 | – – | 4 3 | – – |
| Galileus emerges – | 12 25 50* | – – | 12 39 1 | – – | 3 53 |
| Galileus biſected – | 12 25 56* | 12 39 16 | – – | 3 57 | – – |
| Ariſtarchus biſected. | 12 28 59 | 12 43 8 | – – | 4 46 | – – |

Difference of meridians on a mean – 4′ 16″

M. MECHAIN's Obſervatory was 9′ 23″, and M. MESSIER's 9′ 18″ eaſt of Greenwich.

Thus

Thus I have given a comparative view of the different methods I employed in ſettling the longitude of our Obſervatory, which is in Bootham, about 400 or 500 yards N. W. of the Minſter. The occultations and meridian tranſits of the moon's limb, which make it $4' 25''\frac{1}{2}$, or $1° 6' 23''$, would have been quite ſufficient; but ſtill it is intereſting and uſeful to know how far the others err. With reſpect to the eclipſes of the moon's ſpots, I think that method is in general too much neglected; and that it might be relied on infinitely more, if certain circumſtances were mutually attended to.

1ſt, To be particular in ſpecifying the clearneſs of the ſky; for in hazy weather the reſults are very erroneous.

2dly, To chuſe ſuch ſpots that are well defined, and leave no heſitation as to the part eclipſed.

3dly, That every obſerver ſhould, as much as poſſible, uſe teleſcopes equally powerful; at leaſt let the magnifying powers be the ſame.

A principal objection may ſtill be urged, *viz.* the difficulty of diſtinguiſhing the true ſhadow from the penumbra. Was this obviated, I believe, the reſults would be more exact than from Jupiter's firſt ſatellite: undoubtedly the ſhadow appears better defined if magnified little; but I am much inclined to think, that with high magnifying powers there is greater certainty of chuſing the ſame part of the ſhadow, which perhaps is more than a ſufficient compenſation for the loſs of diſtinctneſs.

## Concerning the meridian obſervations of the moon's limb.

The advantages and preciſion of this method for determining the difference of meridians is, as I have already ſaid, ſo little ſuſpected,

ſuſpected, that I flatter myſelf, the particulars I am going to mention will not be thought ſuperfluous.

The rule I adopted is this:

The increaſe of the moon's R.A. in 12 hours (or any given time) found by computation, is to 12 hours as the increaſe of the moon's R.A. between two places, found by obſervation, is to the difference of meridians.

E X A M P L E.

November 30, 1782.

| | | | |
|---|---|---|---|
| h. ′ ″ | | | |
| 13 12 57,62 | meridian tranſit of the moon's ſecond limb | at Greenwich by clock. | |
| 13 13 29,08 | ditto of α ♍ | | |
| 31,46 | Difference of R.A. | | |
| 13 14 8,05 | meridian tranſit of the moon's ſecond limb | at York by clock. | |
| 13 14 30,13 | ditto of α ♍ | | |
| 22,08 | difference at York, | the clocks going nearly ſidereal time no correction is required. | |
| 31,46 | difference at Greenwich, | | |
| 9,38 | increaſe of the moon's apparent R.A. between Greenwich and York, by obſervation. | | |
| 141″ | in ſeconds of a degree, | ditto, ditto, | ditto. |

The increaſe of the moon's R.A. for 12 hours by computation is 23340 ſeconds, and 12 hours reduced into ſeconds is 43200;

therefore, according to the rule ſtated above,

$$23340'' : 43200'' :: 141'' : \text{difference of meridians} = 261'' -$$

Theſe eaſy obſervations and ſhort reduction are the whole of the buſineſs. Inſtead of computing the moon's R.A. for 12 hours, I have conſtantly taken it from the Nautical Almanacs, which give it ſufficiently exact, provided ſome attention be paid to the increaſe or decreaſe of the moon's motion.

Were the following circumſtances attended to, the reſults would undoubtedly be much more exact.

1ſt, Compare the obſervations to the ſame made in ſeveral other places.

2dly, Let ſeveral and the ſame ſtars be obſerved at theſe places.

3dly, Such ſtars as are neareſt in R.A. and declination to the moon are infinitely preferable.

4thly, Your advice to get as near as poſſible an equal number of obſervations of each limb, to take a mean of each ſet, and then a mean of both means, cannot be too ſtrongly urged. I am perfectly of your opinion, that it will conſiderably correct the error of teleſcopes and ſight.

5thly, The adjuſtment of the teleſcopes to the eye of the obſerver before the obſervation, which you alſo recommend, will appear very judicious to every aſtronomer, who muſt have frequently perceived what you mention, that the ſight is ſubject to vary.

6thly, As a principal error proceeds from the obſervation of the moon's limb, I think it may be conſiderably leſſened, if certain little round ſpots near each limb were alſo obſerved in ſettled Obſervatories; in which caſe the libration of the moon will perhaps be a conſideration.

7thly, When the difference of meridians, or of the latitudes of the places, is very conſiderable, the change of the moon's diameter becomes an equation.

Though ſuch are the requiſites to uſe this method with advantage, only one or two of them have been employed in the obſervations that I have reduced. Two thirds of theſe obſervations had not even the ſame ſtars obſerved at Greenwich and York; and yet none of the reſults, except a doubtful one, differ

differ 15″ from the mean; therefore, I think, we may expect a still greater exactness, perhaps within 10″, if the above particulars be attended to.

When the same stars are not observed, it is necessary for the observers at both places to compute their R.A. from tables, in order to get the apparent R.A. of the moon's limb; though this is not so satisfactory as by actual observation, still the difference will be trifling, provided the stars R.A.'s are accurately settled. Your catalogue undoubtedly may be depended on the most, and those stars preferred which have their proper motions ascertained. A few years ago, I had the pleasure of communicating to you the proper motion of β Virginis, which I found to be 1″,02 *per* year, increasing in R.A.*: was this unknown, and that star observed alone with the moon, it would occasion, at this time, a very considerable error.

I am also of opinion, that the same method can be put in practice by travellers with little trouble, and a transit instrument constructed so as to fix up with facility in any place. Though I have not considered this sufficiently, I shall, nevertheless, subjoin a few remarks that may engage others to turn their thoughts more fully to the subject.

It is not necessary, perhaps, that the instrument should be perfectly in the meridian to a few seconds of time, provided stars, nearly in the *same parallel of declination* with the moon, are observed: nay, I am inclined to think, that if the instrument deviates even a quarter or half of a degree, or more, sufficient exactness can be obtained, as a table might be com-

* Some time previous to this communication, I had found, by the comparison of my transit observations of α Aquilæ and β Virginis, that the latter had moved forward with a proper motion of 0″,91 of time, or of 13″,65 of R.A. from 1767 to 1783, in 16 years, or at the rate of 0″,853 a year, on supposition that the proper motion of α Aquilæ is 0″,57 a year forward.

 puted,

puted, ſhewing the moon's parallax and motion for ſuch deviation, which deviation may eaſily be found by the well known method of obſerving ſtars whoſe difference of declination is conſiderable.

As travellers very ſeldom meet with ſituations to obſerve ſtars near the pole, or find a proper object for determining the error of the line of collimation, I ſhall recommend the following idea, which, I believe, has never yet been noticed, and hope it will anſwer the purpoſe. Having computed the apparent R.A. of four, ſix, or more ſtars, which have nearly the ſame parallel of declination, obſerve half of them with the inſtrument inverted, and the other half when in its right poſition; if the difference of R.A.'s between each ſet by obſervation agree with the computation, there is no error; but if they diſagree, half that diſagreement is the error of the line of collimation. The ſame obſervations may alſo ſerve to determine whether the diſtance of the correſponding wires are equal. In caſe of neceſſity, each limb of the ſun might be obſerved in the ſame manner, though probably with leſs preciſion. By a ſingle trial I made above two years ago, the reſult was much more exact than I expected. MAYER's Catalogue of Stars will prove of great uſe to thoſe that adopt the above method.

In ſuch a number of obſervations, it is not ſurpriſing that a few ſhould be erroneous; I have rejected only three.

| | ′ | ″ |
|---|---|---|
| A meridian tranſit of the moon's limb, Auguſt 18, 1782; δ Sagitarii was the only ſtar obſerved at York; it gives for difference of meridians, . . . | 3 | 55 |
| Perhaps the ſtar has a proper motion, or a miſtake of one ſecond might have been made in marking the clock. | | |
| An immerſion of Jupiter's firſt ſatellite, June 22, 1783, which make the difference of meridians, . | 3 | 42 |

The

The air was hazy both at Greenwich and at York.

Laſtly, an occultation of a ſtar of the ninth magnitude, immerged behind the dark limb of the moon, during the eclipſe of Sept 10, 1783, at 11 h. 29′ 6″ apparent time. M. MESSIER alſo obſerved it at 11 h. 50′ 49″¼ apparent time at Paris: he determined its R.A. 349° 22′ 17″, and declination 5° 38′ 23″ ſouth. M. GOODRICKE, who computes very accurately, finds it gives for difference of meridians, . . . 4. 44¼

I am rather ſurpriſed, that the immerſions of known ſtars of the ſixth and ſeventh magnitude behind the *dark limb* of the moon are not conſtantly obſerved in fixed Obſervatories, as they would frequently be of great uſe.

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## Latitude of York.

The following determinations for the latitude of York were made with a BIRD's 18-inch quadrant, the teleſcope of two feet focus, with which inſtrument obſervations of the ſame ſtar ſeldom differ 10″.

### Latitude of the Obſervatory.

| ° | ′ | ″ | | | |
|---|---|---|---|---|---|
| 53 | 57 | 37 | by 7 | obſervations | of Arcturus. |
| 53 | 57 | 41 | by 2 | ditto | of α Lyræ. |
| 53 | 57 | 52 | by 1 | ditto | of β Arietis. |
| 53 | 57 | 37 | by 1 | ditto | of β Cygni. |
| 53 | 57 | 33 | by 2 | ditto | of Algol. |
| 53 | 57 | 57 | by 4 | ditto | of γ Lyræ. |
| 53 | 57 | 49 | by 8 | ditto | of β Draconis. |
| 53 | 57 | 46 | by 6 | ditto | of μ Draconis. |
| 53 | 57 | 56 | by 2 | ditto | of γ Draconis. |
| 53 | 57 | 45 + | latitude on a mean. | | |

The line of collimation was deduced from $\beta$, $\gamma$, and $\mu$ Draconis; half of each ſet obſerved with the face of the quadrant to the eaſt, and half with its face to the weſt. This, as well as the other methods, is very tedious, particularly when required to be often repeated, as is the caſe in travelling; I ſhall therefore propoſe the following invention, the idea of which was improved on by Mr. SMEATON, and flatter myſelf it will prove of the greateſt facility.

The error of the line of collimation includes the fixed errors of the inſtrument, and thoſe that are ſubject to change, occaſioned by the wires and glaſſes, &c. of the teleſcope moving. The error of theſe laſt may be found by making the teleſcope turn on its center, ſo that the ſun, ſtars, or terreſtrial objects may be obſerved on the horizontal wire in two manners; firſt, when the wire is in its natural poſition, and then inverted, which is performed by turning the teleſcope 180 degrees, or half round: thus, this part of the error can always be known with the greateſt eaſe; and in order to find the fixed errors, it is requiſite for *a ſingle time* to get the *whole error* of the line of collimation by one of the common methods, from which the error of the teleſcope being deducted, the fixed errors become known; and as they are unchangeable, if any alteration ſhould take place, it proceeds from the teleſcope, and may eaſily be detected as ſhewn above. Perhaps, inſtead of the whole teleſcope, it would be ſufficient only to make that part turn containing the eye-glaſs and wires.

As

As the following obſervations made alſo at York may be of uſe, I beg, Sir, you will annex them to my paper on the longitude and latitude of that city, which lately I had the pleaſure of ſending you.

| Dates. | App. time. | | | |
|---|---|---|---|---|
| | h. | ′ | ″ | |
| 1781, July 19 | 9 | 41 | 59 | Emerſion of Jupiter's ſecond ſatellite; night fine. |
| 1782, May 24 | 12 | 23 | 12 | Immerſion of Jupiter's ſecond ſatellite; good. |
| July 20 | 11 | 27 | 40: | Emerſion of Jupiter's 2d ſat.; doubtful; air very hazy. |
| Nov. 30 | 20 | 57 | 16 | Immerſion of $\alpha$ ♍ behind the moon; inſtantaneous. |
| | 20 | 57 | 21½* | Ditto ditto; in another part of the town. |
| | | | | Eclipſe of the moon. |
| 1783, Mar. 18 | 8 | 27 | 50 | Total immerſion of the moon; air very clear. |
| | 8 | 27 | 33* | Ditto; good. |
| | 10 | 9 | 36 | Moon begins to emerge; } air hazy. |
| | 10 | 10 | 18 | Certainly emerged; } air hazy. |
| June 26 | 13 | 35 | 21 | Immerſion of Jupiter's ſecond ſatellite; good. |
| | 13 | 34 | 52* | Ditto; middling. |
| | | | | Eclipſe of the moon; air clear. |
| Sept. 10 | 9 | 30 | 45 | Appearance of penumbra. |
| | 12 | 17 | 30 | Moon not emerged, but light ſtrong. |
| | 12 | 19 | 35 | Ditto; very ſtrong. |
| | 12 | 21 | 14 | Moon begins to emerge, but uncertain. |
| | 12 | 21 | 44 | Ditto; more certain. |
| | 12 | 21 | 56* | Ditto; ditto. |
| | 12 | 22 | 24 | Moon certainly emerged. |
| | 12 | 22 | 24* | Ditto. |
| | 13 | 21 | 00 | End of the eclipſe, doubtful; air hazy. |
| | 13 | 21 | 23* | Ditto. |
| | 13 | 22 | 18* | Certainly ended, but not clear of penumbra. |
| | 13 | 22 | 45 | Ditto, ditto; air clearer. |
| | | | | Several ſpots were obſerved, but are here omitted, for fear of being too voluminous. |
| Sept. 16 | 10 | 22 | 41 | Emerſion of Jupiter's ſecond ſatellite; air clear; but Jupiter low. |
| 23 | 9 | 27 | 18 | Emerſion of Jupiter's 3d ſat.; Jupiter low; undulation. |
| Oct. 11 | 7 | 34 | 9* | Emerſion of Jupiter's ſecond ſatellite. |
| | 7 | 34 | 21 | Ditto; tolerably good. |
| 29 | 5 | 42 | 53 | Emerſion of Jupiter's third ſatellite. |
| | 5 | 46 | 16 | Equal in brightneſs to the ſecond ſatellite; air clear. |
| 1784, July 27 | 10 | 7 | 46 | Immerſion of Jupiter's third ſatellite; tolerably good, though undulation. |

Dates.

| Dates. | App. time. | |
|---|---|---|
| | h. ′ ″ | |
| 1784, Aug. 26 | 8 54 12 | Immerſion of τ ♐ behind the moon; inſtantaneous. |
| Oct. 11 | 9 49 30 | Emerſion of Jupiter's ſecond ſatellite; good, though ſlight haze. |
| | 9 49 26* | Ditto. |
| Nov. 12 | 9 33 59 | Emerſion of Jupiter's ſecond ſatellite. |
| | 9 34 1* | Ditto. |
| 1785, July 15 | 12 26 50 | Immerſion of Jupiter's ſecond ſatellite; air clear. |
| Aug. 18 | 11 44 37 | Immerſion of Jupiter's third ſatellite; good; the air a little vapouriſh. |
| Sept. 17 | 12 16 55 | Immerſion of Jupiter's ſecond ſatellite; good; the air a little vapouriſh. |
| Oct. 29 | 6 33 26 | Emerſion of Jupiter's third ſatellite; the air a little vapouriſh. |
| Nov. 15 | 9 24 ± | I examined Jupiter's fourth ſatellite during 20′, without being certain whether it had diminiſhed in light. |
| Dec. 15 | 5 50 48 | Immerſion of 125 ♉ by the moon, exact within 3″. |

I have again marked with an aſteriſk the obſervations made by Mr. GOODRICKE, who deſired me to communicate them. This worthy young man exiſts no more; he is not only regretted by many friends, but will prove a loſs to aſtronomy, as the diſcoveries he ſo rapidly made ſufficiently evince: alſo his quickneſs in the ſtudy of mathematics was well known to ſeveral perſons eminent in that line.

## Declination of the needle.

| | | | |
|---|---|---|---|
| | h | ° ′ | |
| 1780, Sept. 13. | at $2\frac{1}{2}$, by a mean of 22 trials, | 23 $40\frac{1}{2}$ | Declination weſt. |
| 1782, Dec. 26. | at $0\frac{3}{4}$, by a mean of 16 trials, | 23 5+ | |
| 1783, Nov. 14. | at $0\frac{3}{4}$, by a mean of 19 trials, | 23 59− | |
| 1784, Jan. 17. | at $0\frac{2}{3}$, by a mean of 13 trials, | 23 54+ | |

Theſe obſervations were taken with all poſſible exactneſs; the needle was four inches long, and made by DOLLOND.

Sir H. ENGLEFIELD, when at Scarborough, in Auguſt and September, 1781, was ſo kind as to obſerve, at noon, the height of his barometer and thermometer. I alſo made ſimilar obſervations

obſervations in the Obſervatory at York; from which, by eight compariſons, none diſagreeing above 0,018 of an inch from the mean, I find, that the quickſilver at the ſea ſtood 0,063 of an inch higher than at York. The barometers were made by RAMSDEN, and they agreed together to 0,005 part of an inch. We may later alſo expect to get the mean height of the barometer and thermometer, as there are ſeveral gentlemen, that obſerve them every day, particularly Mr. WYVIL and Dr. WHITE at York, and Mr. CHOMONLEY at Branſby.

I remain, Sir, with great regard, &c.

EDW. PIGOTT.

May 26, 1786.